REMARKS

The Examiner's objections to the drawings have been attended to by amendment to the drawings or the specification.

Claim 8 has been amended so as to overcome the rejection of the claim under 35 USC § 112.

The Examiner has rejected claims 1 - 8 under 35 USC 103(a) as being unpatentable over US 5 858 191 (DiMascio) in view of US 2 970 098 (Ellis).

US 5 858 191 (DiMascio) discloses an electrode ionization apparatus and a method of deionization which apparatus includes an ion concentrating compartment, an ion depleting compartment and electrolyte compartments with alternating layers of anion exchange resins and cation exchange resins positioned in the ion-depleting compartment. The ion exchange resins comprise Type II anion resins. The incorporation of such type II anion resin material, alone or together with Type I anion material, in anion permeable resins improves the electric current distribution, the degree of resin regeneration and the deionization performance..

US 2 970 098 (Ellis) discloses an electrodialysis apparatus for the separation of dissolved ionizable substances from a solvent by the use of anion permeable and cation permeable membranes or the transfer of dissolved ionizable substances from one body of liquid to another. The apparatus comprises a pair of spaced electrodes forming therebetween a space which is filled with capsules which are so arranged that a line of current flow can be established through a plurality of such capsules, each of the capsules having opposite wall portions which are selectively anion or cation permeable. The capsules are so arranged that the anion permeable wall portions face toward one of the electrodes and the cation permeable wall portions face toward the other of the electrodes.

It is noted that only US 5 858 191 discloses an electrode deionization device whereas US 2 970 098 discloses an electrodialysis system. Such an electrodialysis system includes ion exchanger membranes, but it does not include ion exchanger particles (mixed bed) between the membranes which is a basic feature of an electrode deionization system (EDI) of the type with which the present invention is concerned.

In an ED1, ions to be removed from an aqueous solution are exchanged mostly already by the respective ion exchange resin fraction of the mixed bed for H^+ or OH^- ions and are re-

moved thereby from the solution (see page 3, second full paragraph of the description). The ions are then transported within the ion exchanger toward the membranes. The H^+ and OH^- ions transferred to the solution are newly generated continuously by water dissociation at the contact points of two different ion exchange particles (that is, the cation - and anion exchanges must be in contact with one another) so that a continuous EDI operation is possible (see page 3, third full paragraph).

For an EDI, it is essential that there is a close contact between the particles of an ion exchange resin fraction and the respective ion exchange membranes which requires an agglomeration of same type particles (see page 3, last paragraph).

For improving such contacts, US 5 858 191 provides an arrangement of the two ion exchange particle fractions in layers as it is well-known and as it has been described in the description of the prior art by reference to the publication [3] (US 4 636 296). (See page 4, paragraph 3).

Like US 5 858 181, the present invention provides for a layer-like arrangement of the two ion exchanger particle fractions (for the H^+ or OH^- ions). In contrast to the cited reference (US 5 858 181) however, one of the fractions - in accordance with the invention - has magnetic properties (see column 1). Furthermore, the EDI device includes means for generating a magnetic field with field lines which extend essentially normal to the ion exchanger membranes for orienting the magnetic resin particles and arranging them in mutually repelling chains between the ion exchanger membranes (see claim 1, feature f).

As a result, the magnetic particles are arranged in the magnetic field in the form of stable chains of adjoining magnetic particles which are in close contact with the chains however repelling one another (page 5, paragraph 3).

As these chain structures have a relatively firm pitch, (page 6, first full paragraph), losses in the efficiency of the ion transfer are greatly reduced.

With the present invention, an ideal mixture of magnetic and non-magnetic fractions is obtained by a suitable magnetic field in a simple manner wherein a complex three-dimensional structure is formed which is ideal for the conditions required for an EDI: first, chains of the magnetic particles are formed which chains however are repelling one another such that their distance from one another is the largest possible for a particular given space. In this way, the chains are arranged spaced from one another in the given space and the spaces between the

chains can be filled with non-magnetic particles. This three-dimensional orderly structure provides for the largest possible charge of the two ion exchanger types while, at the same time, forming continuous chains in a direction normal to the membrane surfaces.

The arrangement according to the invention is clearly superior to the alternating layer structure of cation and anion exchanges as described in US 5 858 181 and also in US 4 636 296 [3]. This is because within a layer of, for example, cation exchanger particles, the solution suffers, caused by the exchange of Na^+ ions for H^+ ions, a rapid pH decrease which detrimentally affects any further exchange of cations (see description on page 5, first full paragraph). Only when the solution reaches the next layer of anion exchangers, the excess H^+ ions are neutralized by the OH^- ions released in the layer. Further, anion exchange leads to an excessively high pH value of the solution which again must be neutralized in the subsequent cation exchange layer.

Only the constant mutual neutralization of the H^+ and OH^- ions as provided in the device according to the invention results in an optimal EDI procedure with a maximum tendency for the exchange of undesired ions. It is quite clear that the arrangement of individual chains of ion exchanger particles in accordance with the invention will much better achieve the needed local continuous neutralization than an arrangement of more or less thick layers of the respective ion exchanger particle fractions.

The cited US 5 858 181 furthermore defines in claim 1 intermediate layers disposed between the attenuating layers of anion exchange resins and cation exchange resins which separate these layers and therefore further delay the required neutralization.

US 5 858 181 proposes therefore a solution which, though providing for a separation between the anion and cation layers, leads a person skilled in the art further away from the arrangement according to the present invention.

Also, US 2 970 098 includes no hint which would lead to the arrangement according to the present invention:

US 2 970 098 includes complex spheres provided with permanent magnets for spatially uniformly orienting the spheres. All spheres are essentially of the same design and include a magnet which is accommodated in a relatively small part of the sphere volume. However, because of the relatively large distance between the magnets in different spheres, the magnets

may be useful for orienting the spheres in a magnetic field but they are not suitable for forming chains of the spheres.

A spatial uniform orientation of identical spheres by means of magnets installed in the spheres as described in US 2 970 098, and a layer arrangement as disclosed in US 5 858 181 will certainly not lead a person skilled in the art to the device as defined in claim 1 of the present application wherein mutually repelling spaced chains of one type of resin particles are arranged in a compartment in spaced relationship and the spaces between the chains are filled with the other type of resin particles.

Reconsideration of claim 1 as amended is respectfully requested.

Claims 2 to 8 relate to embodiments which are considered to be advantageous in connection with the device as defined in claim 1. Claims 2 to 8 are all dependent directly or indirectly on claim 1 and, consequently, include all the features of claim 1.

They should be patentable already for that reason.

Reconsideration of the rejection of these claims is respectfully requested and allowance of claims 1 to 8 is solicited.

Respectfully submitted,

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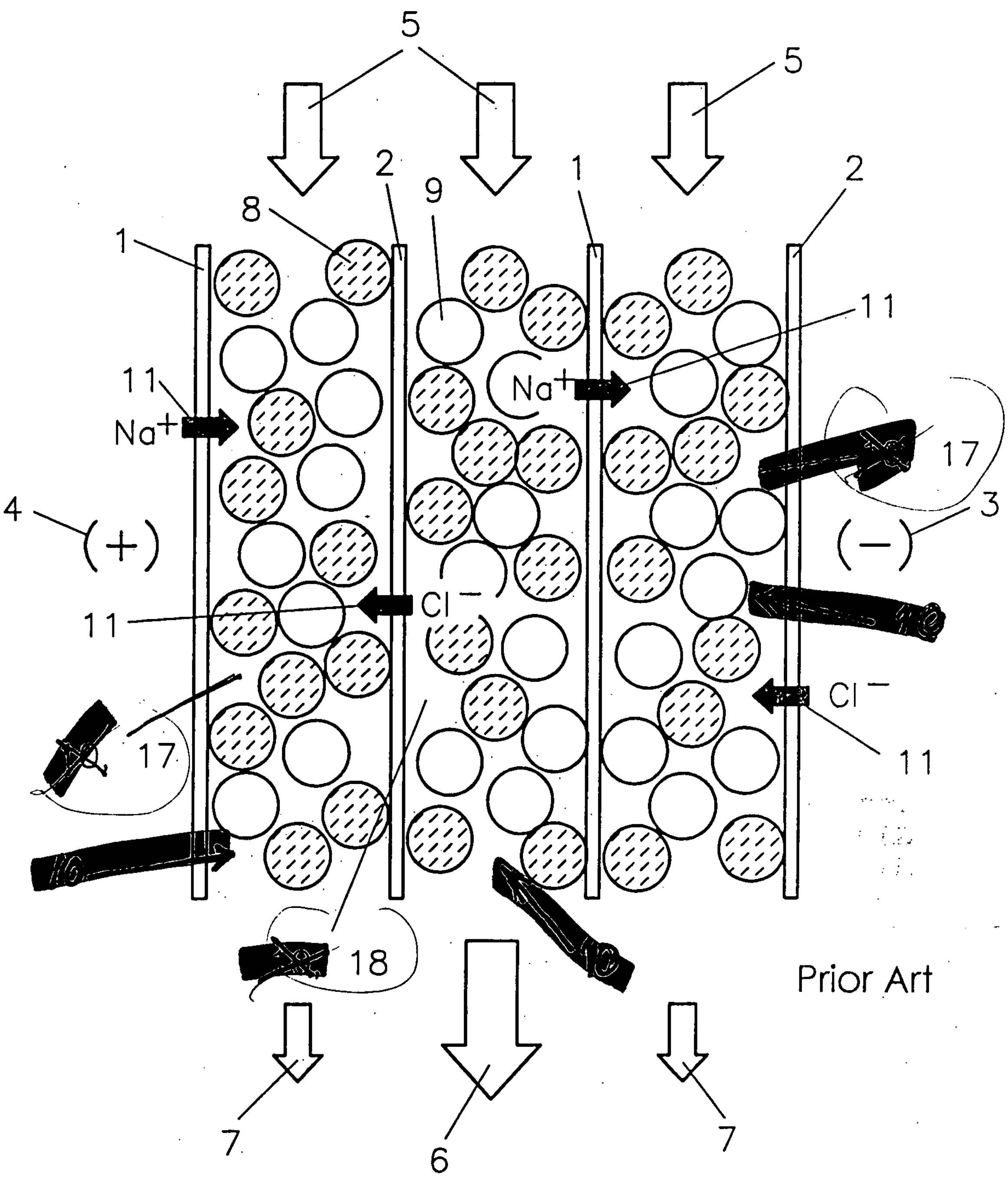
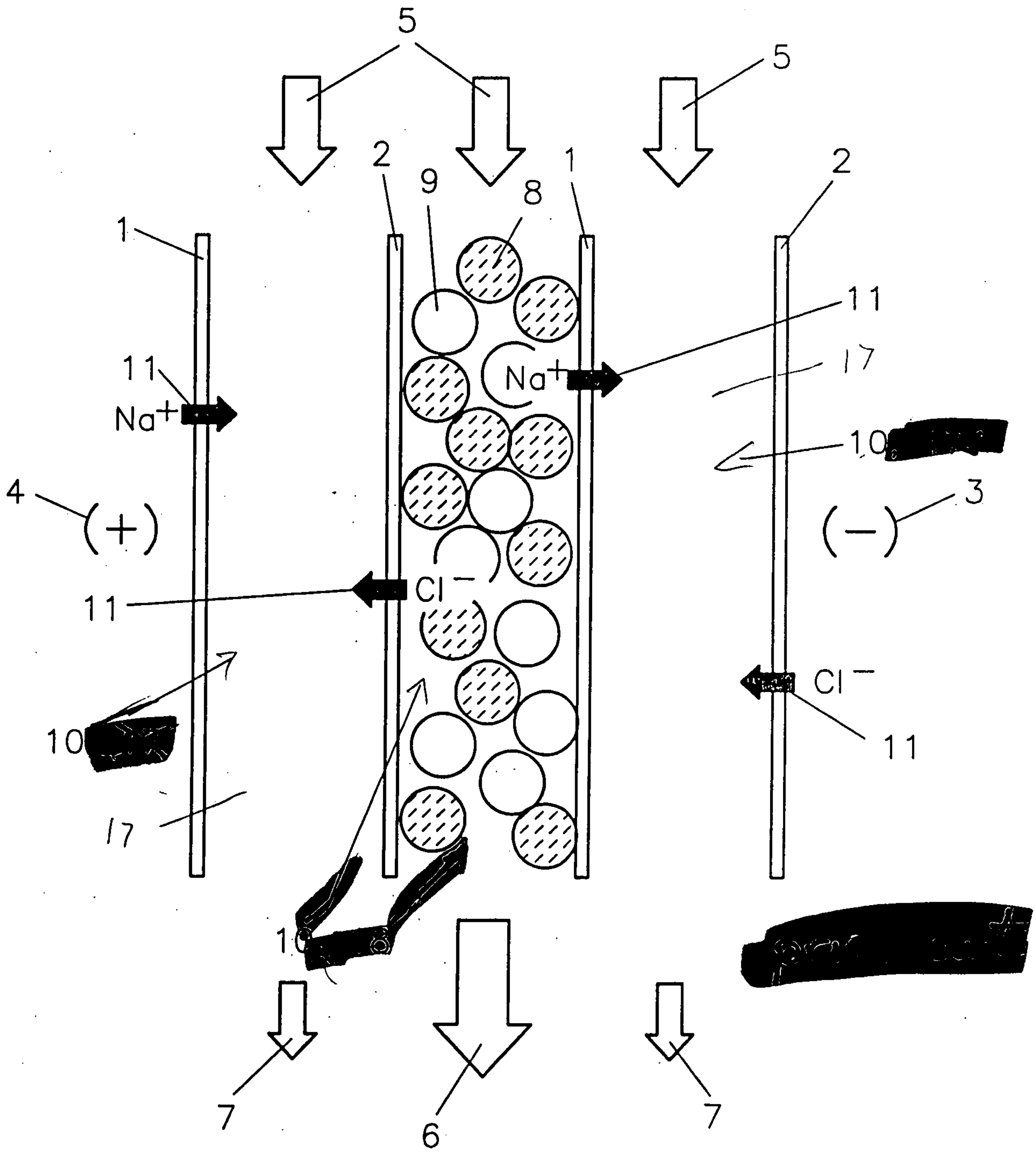
Fig. 1a



Prior Art

Fig. 1b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5
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9
8
1
2
1
11
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11
Na+
17
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4
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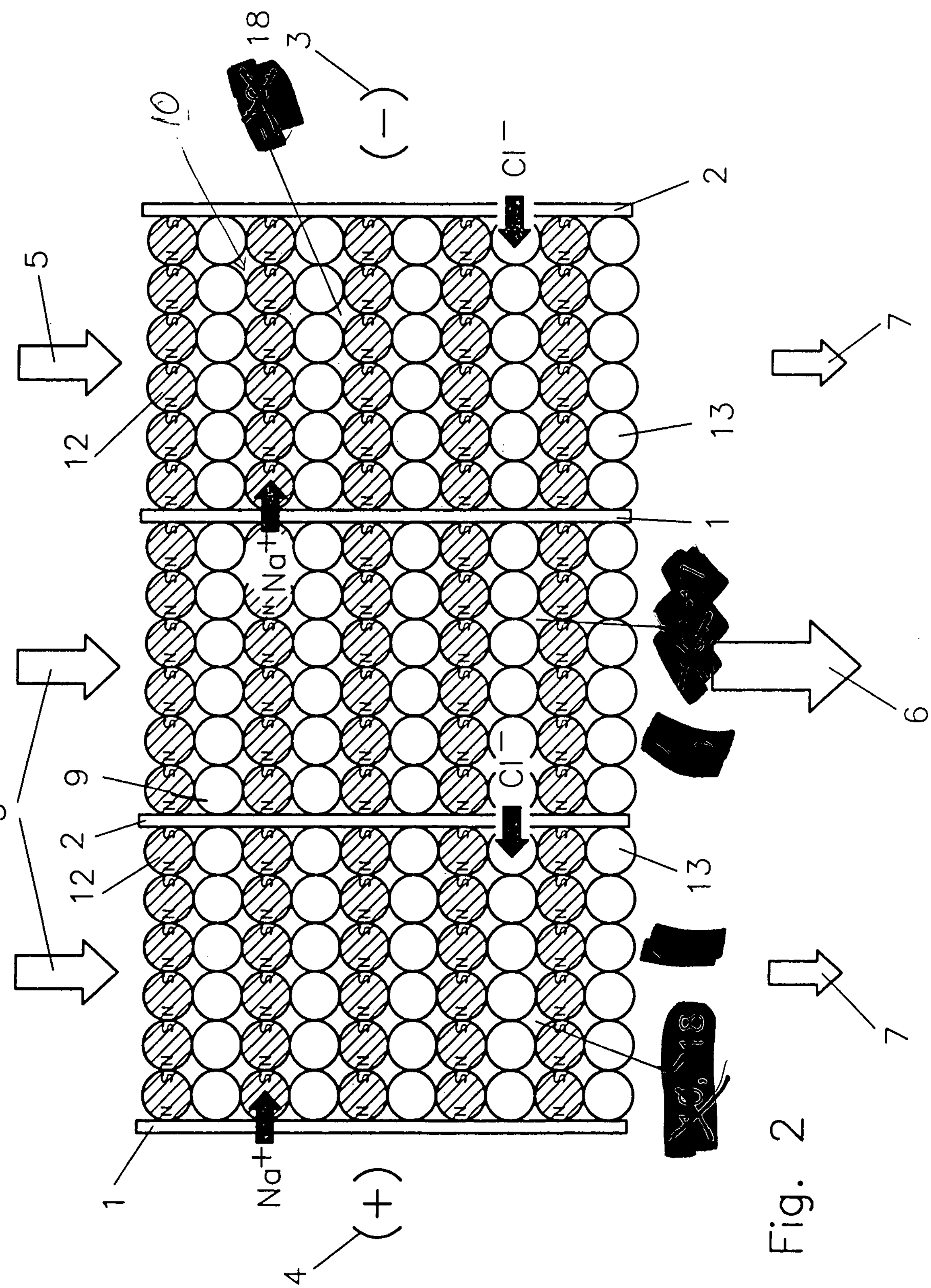

Fig. 2

Fig. 3